ARPA-E's Methane Pyrolysis Cohort 2nd Annual Program Review

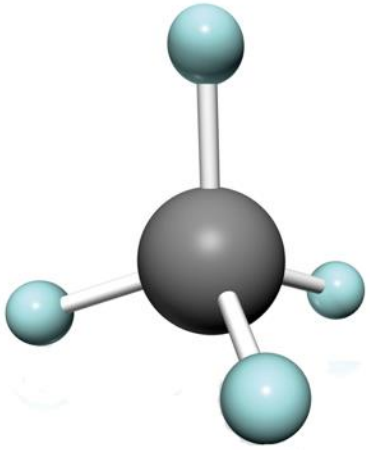
Opening Remarks

Jack Lewnard

Program Director @ ARPA-E

January 12, 2022

Methane Pyrolysis – Opportunity for Two Products



750 - 1200°C

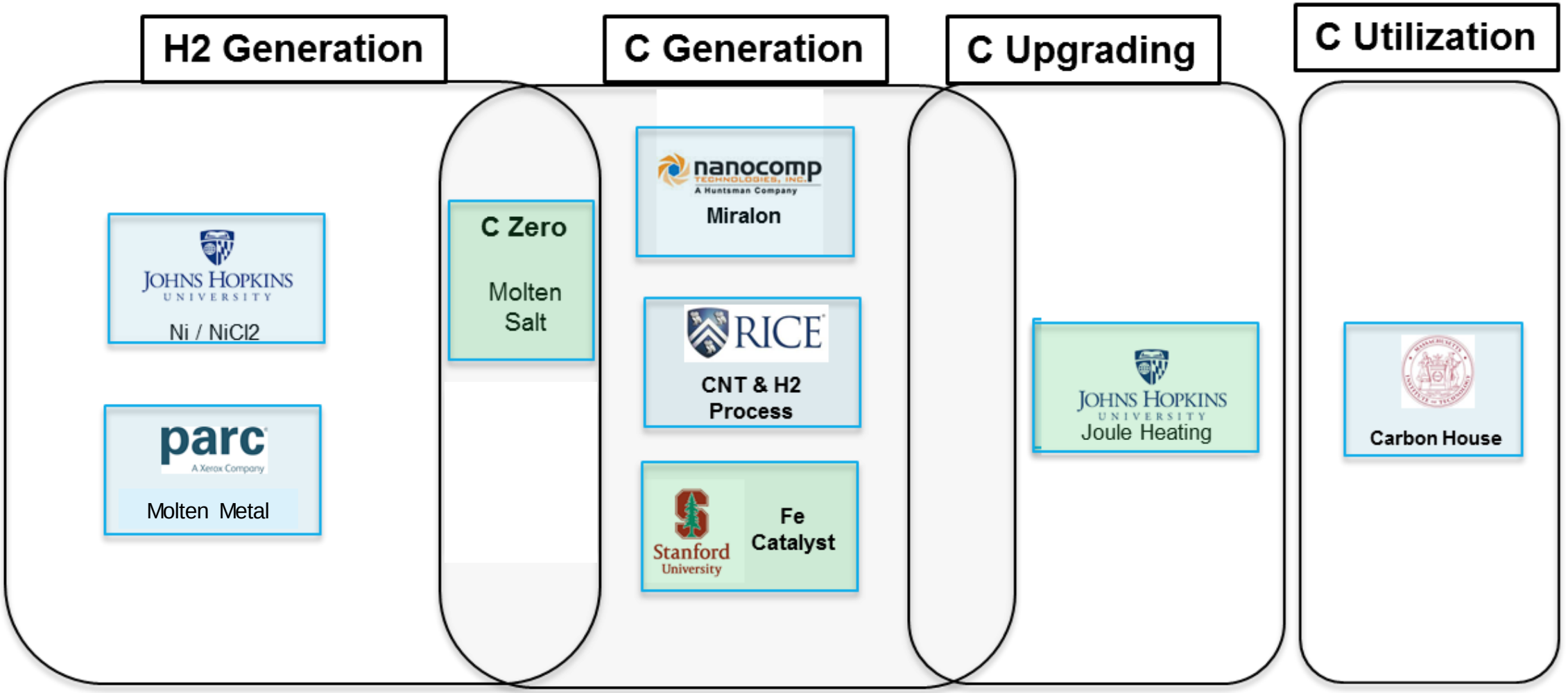
Gaseous hydrogen

+

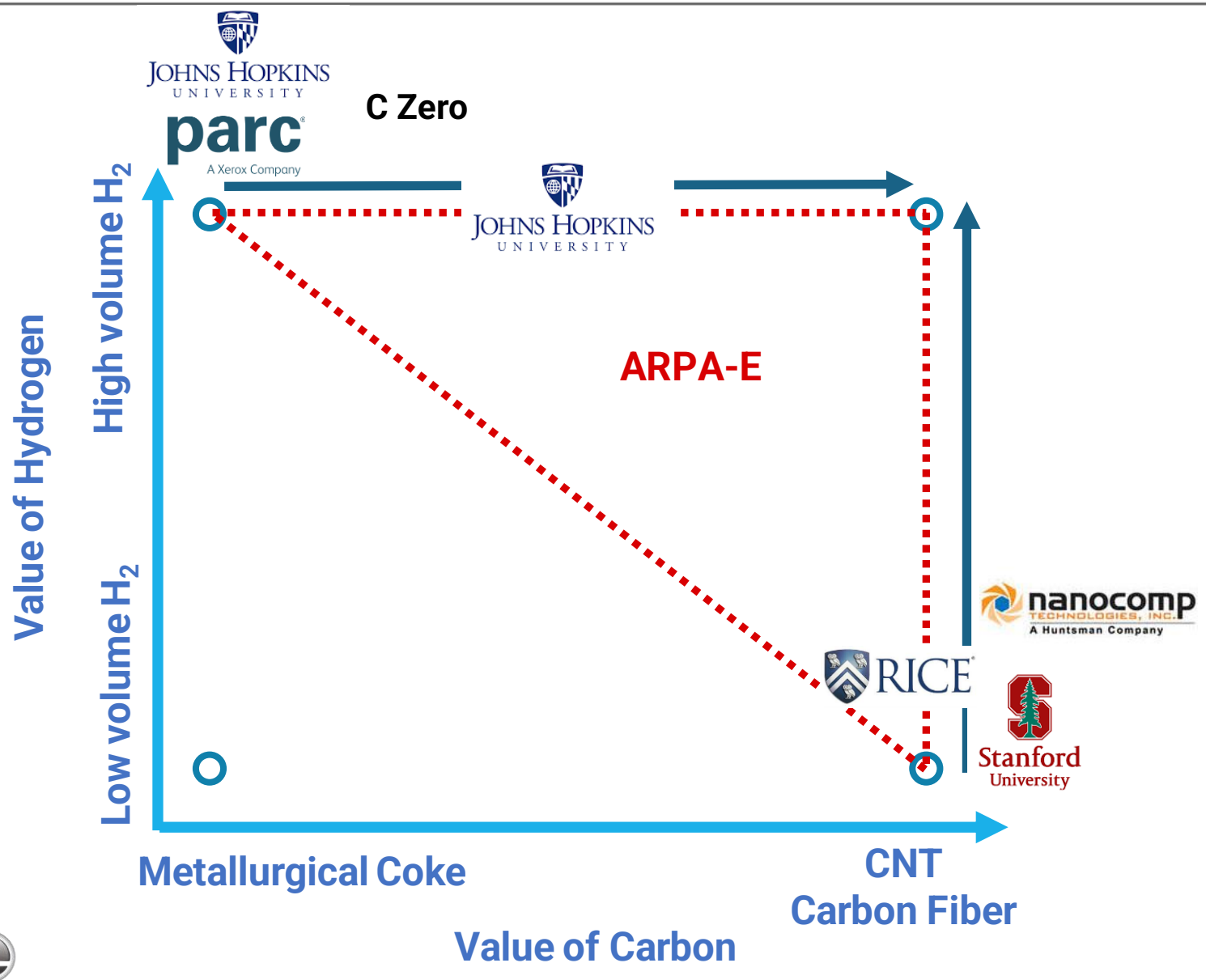
Solid carbon

$CH_4 \longrightarrow 2\,H_2 + C\,(s)$

Methane Pyrolysis Cohort.. 2018 OPEN & 2019 FOA



Cohort was assembled with 2-pronged approach in mind



New Carbon Applications

MIT

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CHANGING WHAT'S POSSIBLE

Goals for this 2nd Annual Methane Pyrolysis Review Meeting

- Update on progress and challenges by performers
- Assess the value proposition of methane pyrolysis for hydrogen and/or carbon production as part of the broader DOE Hydrogen Shot initiative
- Identify key challenges for future programs, likely through DOE Fossil Energy and Carbon Management (FECM)
- Building the community for future projects by strengthening connections among the 120+ attendees, including scientists, engineers, business, investors and government

Today's Schedule

January 12, 2022		
TIME (EASTERN)	TITLE	SPEAKER
10:30 – 11:00 AM	Log-in & Communication Check	Nancy Hicks, Booz Allen Hamilton
11:00 – 11:05 AM	ARPA-E Welcome Message	Isik Kizilyalli, Associate Director for Technology, ARPA-E
11:05 – 11:15 AM	Hydrogen Production through Methane Pyrolysis	Jack Lewnard, Program Director, ARPA-E
11:15 – 11:35 AM	Challenges in Methane Pyrolysis	Chris Mesrobian, Director of Technology, Monolith Materials
11:35 – 11:55 AM	Hydrogen Production Cost Model Overview (H2Fast)	Michael Penev, Sr. Chemical Engineer, NREL
11:55 – 12:00	BREAK	
12:00 – 1:20 PM	Performer Project Overviews: Hydrogen-Focused Projects 15 min presentations + 5 min Q&A	Brad Rupp (PARC, OPEN 2018) Jonah Erlebacher (JHU, OPEN 2018) Eric McFarland (C-Zero, TINA 2019) Alan Weimer (U.Colorado, H2@scale)
1:20 – 1:50 PM	LUNCH BREAK	
1:50 – 2:50 PM	Scale up panel Moderator: Kirk Liu, ARPA-E	Dan Hancu, DOE FECM Leonardo Spanu, Shell Steven Pyl, ExxonMobil Brad Russell, UOP
2:50 – 3:00 PM	BREAK	
3:00 – 4:40 PM	Performer Project Overviews: Carbon-Focused Projects 15 min presentations + 5 min Q&A	Matteo Pasquali (Rice U., OPEN 2018) David Gailus (Nanocomp, OPEN 2018) Matteo Cargnello (Stanford U., TINA 2019) Chao Wang (JHU, TINA 2019) Ranjani Siriwardane (NETL, H2@scale)
4:40 – 4:50 PM	BREAK	
4:50 – 5:50 PM	Carbon products panel Moderator: Marina Sofos, ARPA-E	Dave Matheu, Cabot Srinivas Siripurapu, Prysmian Mark Goulthorpe, MIT Robert Cavaliero, EdenCrete
5:50 – 6:00 PM	Closing remarks	Jack Lewnard, Program Director, ARPA-E

H_2 Generation.. Competitive Landscape

Process	Yield	Cost	GHG produced	Value of C/CO_2 ($/tonne)	H_2O required
SMR	$4H_2/CH_4$	~1-1.2 $/kg *depends on the price of natural gas*	9-10 gCO_2/gH_2	0	Yes
SMR + CCS	$< 4H_2/CH_4$	~2 $/kg *depends on the price of natural gas*	< 3 gCO_2/gH_2	35 - 50 $/tonne$_{CO2}$	Yes
H_2O electrolysis (renewables)	~ 60% energy efficient	~4 $/kg *depends on the price of electricity*	No direct CO_2 emitted	N/A	Yes, significant
Methane pyrolysis	$2H_2/CH_4$	Target: <1.5 $/kg *depends on the price of natural gas*	<3 gCO_2/gH_2	>100 $/tonne$_C$	No

President Biden and Energy Secretary Granholm at Climate Summit

"…I've asked the Secretary of Energy to speed the development of critical technologies to tackle the climate crisis. No single technology is the answer on its own because every sector requires innovation to meet this moment."

President Joseph R. Biden
April 23, 2021

Launch of Hydrogen Energy Earthshot
First of the Energy Earthshots
June 7, 2021
at DOE Hydrogen Program Annual Merit Review

Secretary Jennifer Granholm
June 7, 2021

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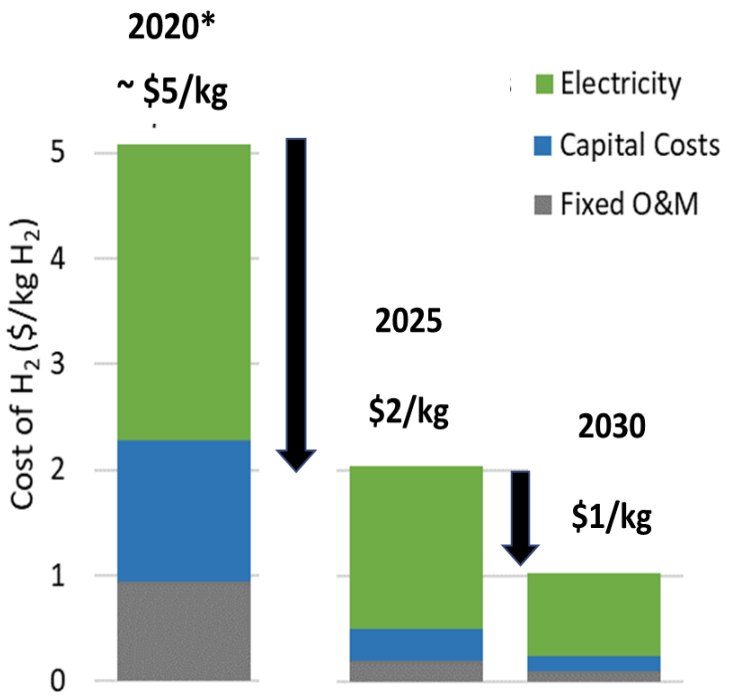
Hydrogen Energy Earthshot

"Hydrogen Shot"

"1 1 1"
$1 for 1 kg clean hydrogen in 1 decade

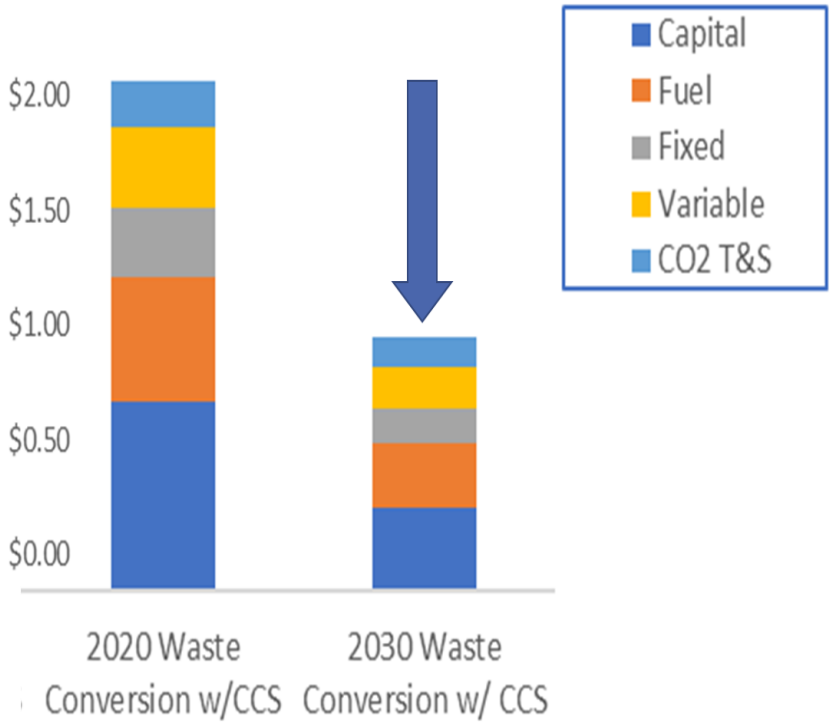
All pathways with potential for "1 1 1" being assessed

H_2 from Electrolysis



- Reduce electricity cost, improve efficiency and utilization
- Reduce capital cost >80%; operating & maintenance cost >90%

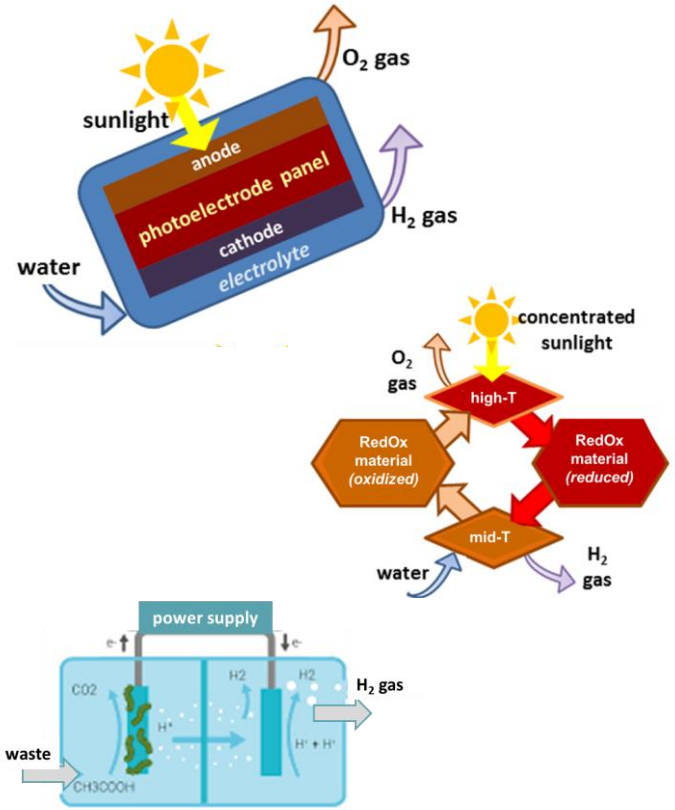
H_2 from Waste Conversion + CCS



* Waste coal, plastics, biomass residuals, municipal solid waste (MSW), and biogas

- Reforming, pyrolysis, air separation, catalysts, CCS, upstream emissions

Advanced Pathways



- Photelectrochemical (PEC), thermochemical, biological, etc.

*2020 Baseline: PEM (Polymer Electrolyte Membrane) low volume capital cost ~$1,500/kW, electricity at $50/MWh. Pathways to targets include capital cost < $300/kW by 2025, < $150/kW by 2030 (at scale). Assumes $50/MWh in 2020, $30/MWh in 2025, $20/MWh in 2030

ARPA-E Scale-Up 2021

- FOA is live, in quiet period
- Information at https://arpa-e.energy.gov/technologies/scaleup/scaleup-2021